

## C3247 Log Data Report

### Borehole Information:

<b>Borehole:</b> C3247		<b>Site:</b> 216-A-10 Crib			
<b>Coordinates</b> (WA State Plane)		<b>GWL (ft)<sup>1</sup>:</b> Dry	<b>GWL Date:</b> 10/03/2003		
<b>North</b> N/A <sup>3</sup>	<b>East</b> N/A	<b>Drill Date</b> Oct. 2003	<b>TOC<sup>2</sup> Elevation</b> N/A	<b>Total Depth (ft)</b> 318	<b>Type</b> Cable Tool

### Casing Information:

<b>Casing Type</b>	<b>Stickup (ft)</b>	<b>Outer Diameter (in.)</b>	<b>Inside Diameter (in.)</b>	<b>Thickness (in.)</b>	<b>Top (ft)</b>	<b>Bottom (ft)</b>
Carbon Steel	1.8	11	9 3/4	5/8	+1.8	80
Carbon Steel	2.2	9.0	8.0	1/2	+2.2	140
Carbon Steel	2.5	6 5/8	5 1/2	9/16	+2.5	316
The logging engineer measured the outside casing diameter with a caliper. Inside casing diameter and the caliper were measured using a steel tape; measurements were rounded to the nearest 1/16 in. Casing thickness was calculated. The driller supplied casing depth. The stickup was measured using a steel tape.						

### Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drillpipe in stages through single strings of casing. Borehole coordinates and elevation were not available.

### Logging Equipment Information:

<b>Logging System:</b> Gamma 1E	<b>Type:</b> 70% HPGe (34TP40587A)
<b>Calibration Date:</b> 07/2003	<b>Calibration Reference:</b> GJO-2003-468-TAR
	<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0

<b>Logging System:</b> Gamma 2A	<b>Type:</b> 35% HPGe (34TP20893A)
<b>Calibration Date:</b> 09/2002	<b>Calibration Reference:</b> GJO-2002-383-TAC
	<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0

<b>Logging System:</b> Gamma 2F	<b>Type:</b> Moisture (H380932510)
<b>Calibration Date:</b> 9/2003	<b>Calibration Reference:</b>
	<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0

**Spectral Gamma Logging System (SGLS) Log Run Information:**

Log Run	1	2/Repeat	3	4/Repeat	5
Date	9/19/03	9/19/03	9/22/03	9/22/03	10/03/03
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	75.0	50.0	139.0	91.0	317.0
Finish Depth (ft)	0	40.0	74.0	81.0	180.0
Count Time (sec)	200	200	200	200	100
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
ft/min	n/a <sup>4</sup>	n/a	n/a	n/a	n/a
Pre-Verification	BA213CAB	BA213CAB	BA214CAB	BA214CAB	AE042CAB
Start File	BA213000	BA213076	BA214000	BA214066	AE042000
Finish File	BA213075	BA213086	BA214065	BA214076	AE042137
Post-Verification	BA213CAA	BA213CAA	BA214CAA	BA214CAA	AE042CAA
Depth Return Error (in.)	0	0	n/a	0	+1
Comments	No fine-gain adjustment. First casing string log run.		Fine-gain adjustment after files -005, -020, -033, -069. Intermediate casing log run.		Fine-gain adjustment after files -002, -014, and -127.

Log Run	6/Repeat	7			
Date	10/6/03	10/6/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	198.0	179.0			
Finish Depth (ft)	180.0	139.0			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N	N			
Pre-Verification	AE043CAB	AE043CAB			
Start File	AE043000	AE043019			
Finish File	AE043018	AE043059			
Post-Verification	AE043CAA	AE043CAA			
Depth Return Error (in.)	n/a	-1			
Comments	Repeat section.	No fine-gain adjustment.			

**Neutron-Moisture Logging System (NMLS) Log Run Information:**

Log Run	1	2/Repeat	3	4/Repeat
Date	9/19/03	9/19/03	09/22/03	09/22/03
Logging Engineer	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	59.0	75.0	81.0
Finish Depth (ft)	75.75	67.0	139.50	91.0
Count Time (sec)	n/a	n/a	n/a	n/a
Live/Real	n/a	n/a	n/a	n/a
Shield (Y/N)	n/a	n/a	n/a	n/a
MSA Interval (ft)	0.25	0.25	0.25	0.25
ft/min	1.0	1.0	1.0	1.0
Pre-Verification	BF093CAB	BF093CAB	BF094CAB	BF094CAB

Log Run	1	2/Repeat	3	4/Repeat
Start File	BF093000	BF093304	BF094000	BF094259
Finish File	BF093303	BF093336	BF094258	BF094299
Post-Verification	BF093CAA	BF093CAA	BF094CAA	BF094CAA
Depth Return Error (in.)	n/a	0.5 high	n/a	0
Comments	No fine-gain adjustment.	Repeat section	None	Repeat section

Log Run	5	6/Repeat	7	8
Date	10/06/03	10/07/03	10/07/03	10/07/03
Logging Engineer	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	138.0	162.0	180.25	279.0
Finish Depth (ft)	180.0	180.0	280.0	318.0
Count Time (sec)	n/a	n/a	n/a	n/a
Live/Real	n/a	n/a	n/a	n/a
Shield (Y/N)	n/a	n/a	n/a	n/a
MSA Interval (ft)	0.25	0.25	0.25	0.25
ft/min	1.0	1.0	1.0	1.0
Pre-Verification	BF095CAB	BF096CAB	BF096CAB	BF096CAB
Start File	BF095000	BF096000	BF096073	BF096473
Finish File	BF095168	BF096072	BF096472	BF096629
Post-Verification	BF095CAA	BF096CAA	BF096CAA	BF096CAA
Depth Return Error (in.)	0	n/a	n/a	+1
Comments	None	Repeat section	New sub-directory created to keep the number of files below 500.	None

### **Logging Operation Notes:**

Zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed with a centralizer installed on the sonde. After each log run on 9/19/03 and 9/22/03, the sonde was warm to the touch. The well site geologist also reported warm samples.

SGLS data were collected using logging systems Gamma 2A and Gamma 1E. Pre- and post-survey verification measurements for Gamma 2A employed the Amersham KUT ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ) verifier with serial number 082. Pre- and post-survey verification measurements for Gamma 1E employed the Amersham KUT ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ) verifier with serial number 118.

### **Analysis Notes:**

<b>Analyst:</b>	Sobczyk	<b>Date:</b>	10/13/03	<b>Reference:</b>	GJO-HGLP 1.6.3, Rev. 0
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SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits. All of the verification spectra were within the control limits except for spectra AE042CAB, AE042CAA, AE043CAB, BA213CAB, BA214CAB, and BA214CAA. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were between 13 percent higher and 5 percent lower at the end of the day. Examinations of spectra indicate that the detector functioned normally during all of the logging runs, and the spectra are accepted.

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. All of the verification spectra were within the control limits except for spectrum BF093CAB. This spectrum was slightly above the upper control limit.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G1EJul03.xls and G2AFeb03.xls), using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The casing configuration was assumed to be one string of 10-in. casing to 77 ft, one string of 8-in. casing to 140 ft, and one string of 6-in. casing to 317 ft (total logged depth). The casing correction factor was calculated using casing thicknesses of 5/8 in., 1/2 in., and 9/16 in., for the 10-in., 8-in., and 6-in. casings, respectively. Because the borehole was logged in stages, the casing correction is not additive as the borehole was logged through one string of casing during each logging run. A water correction was not needed or applied to the data.

Using the SGLS, a maximum dead time of 50 percent was encountered in the interval at 62 ft. Concentrations in borehole intervals where the dead time exceeds 40 percent tend to be underestimated because of peak spreading and pulse pileup effects. Because only one point exceeded 40 percent, additional logging with the HRLS was not warranted. SGLS dead time corrections were applied when dead time surpassed 10.5 percent.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. Zero reference was the ground surface. The volume fraction of water was not calculated because calibration data are not available for the 10-in. casing.

### **Log Plot Notes:**

Separate log plots are provided for gross gamma and dead time, gross gamma and neutron total counts, naturally occurring radionuclides ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ), and man-made radionuclides. The neutron-moisture data are displayed in a counts per second format on the combination plot so the data can be compared over the entire length of the borehole. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The  $^{214}\text{Bi}$  peak at 1764 keV was used to determine the naturally occurring  $^{238}\text{U}$  concentrations on the combination plot rather than the  $^{214}\text{Bi}$  peak at 609 keV because it exhibited slightly higher net counts per second.

### **Results and Interpretations:**

$^{137}\text{Cs}$  and  $^{154}\text{Eu}$  were the man-made radionuclides detected in this borehole.  $^{137}\text{Cs}$  was detected near the ground surface (0 ft and 1 ft) at concentrations ranging from 0.5 to 4.5 pCi/g.  $^{137}\text{Cs}$  was detected in the interval from 48 to 84 ft at concentrations ranging from 0.3 to 2,800 pCi/g. The maximum concentration of  $^{137}\text{Cs}$  was measured at 62 ft.  $^{137}\text{Cs}$  was also detected at 31 ft, 99 ft, 120 ft, 228 ft, and 244 ft with concentrations near the MDL of 0.3 pCi/g.  $^{154}\text{Eu}$  was detected in the interval from 83 to 85 ft at concentrations ranging from 0.4 to 1.5 pCi/g.

The low KUT concentrations between 33 and 40 ft probably correspond with the rock fill that is located near the base of the crib. The neutron counts per second is depressed in this interval as well. Between 288 and 293 ft, there is an apparent 0.3-pCi/g increase in  $^{232}\text{Th}$  concentration. Near 80 and 140 ft, there is an apparent 5-pCi/g decrease in  $^{40}\text{K}$  concentration. These changes are associated with the different geometry near the base of the borehole as it was logged in stages.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS and NMLS data. The man-made and natural radionuclides at energy levels of 662, 609, 1274, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. The trace amounts of  $^{137}\text{Cs}$  detected at 83 ft and 89 ft on the repeat log were not detected on the original log run.

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<sup>1</sup> GWL – groundwater level

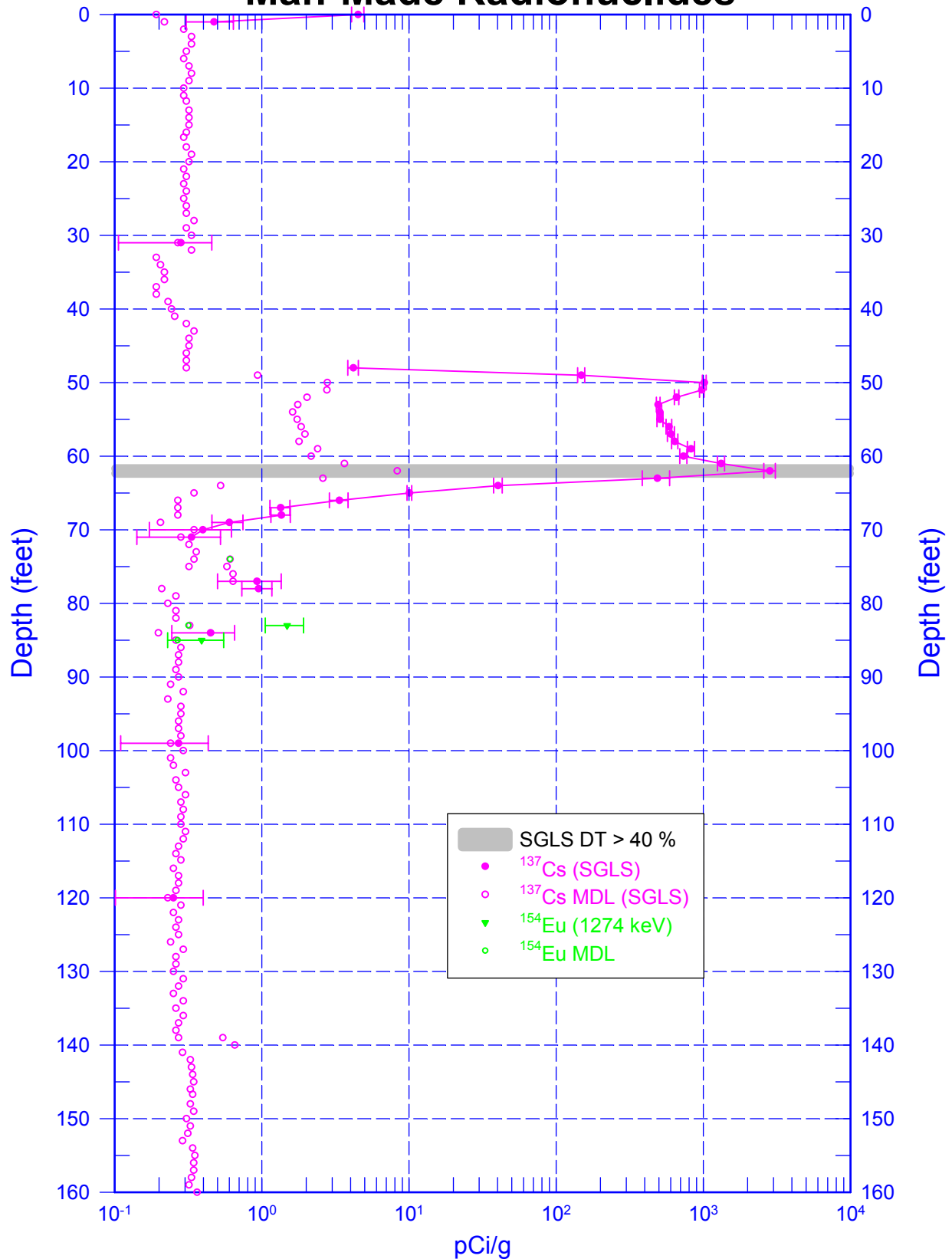
<sup>2</sup> TOC – top of casing

<sup>3</sup> n/a – not available

<sup>4</sup> N/A – not applicable

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## Man-Made Radionuclides

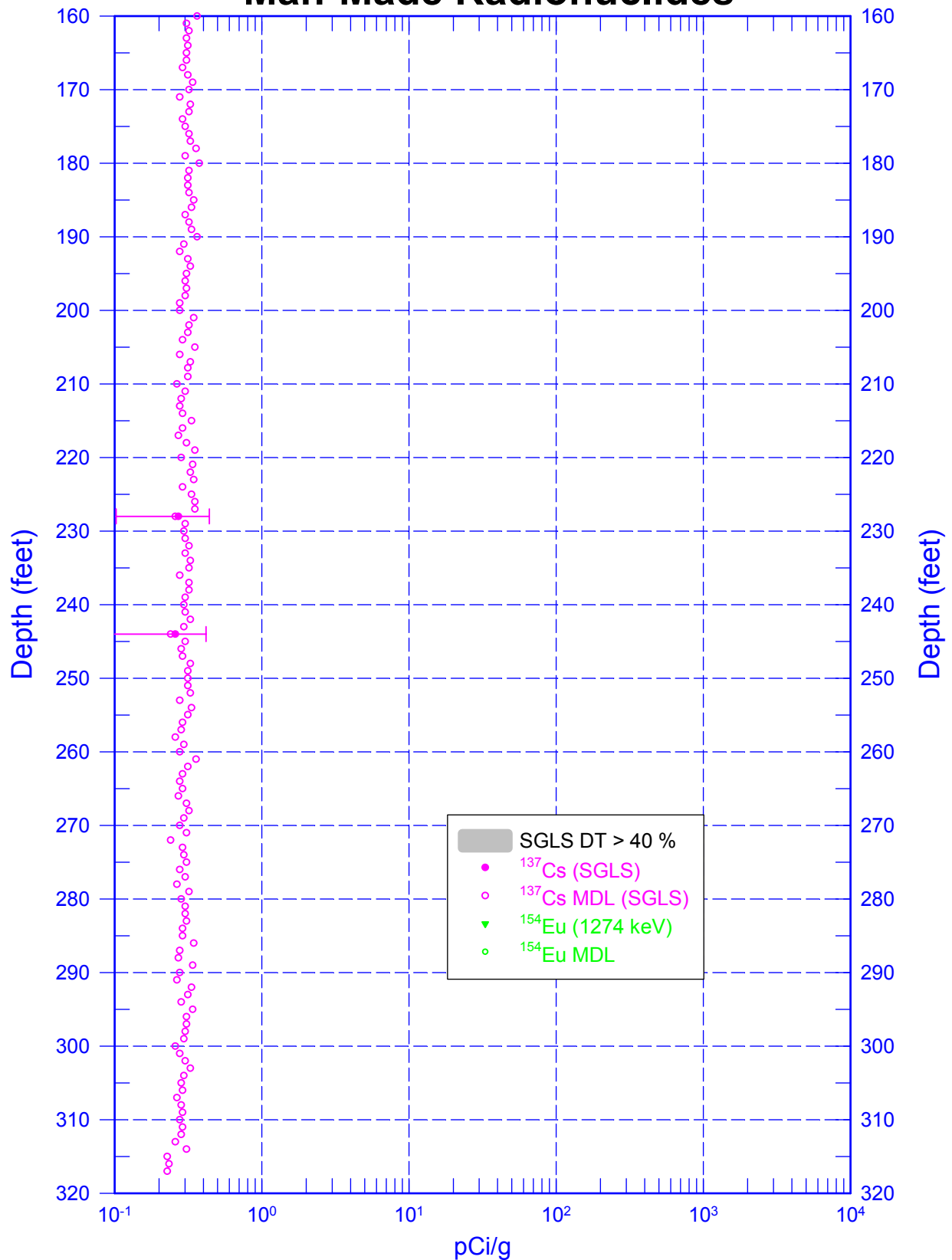


Zero Reference = Ground Surface

Date of Last Logging Run  
10/07/2003

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## Man-Made Radionuclides

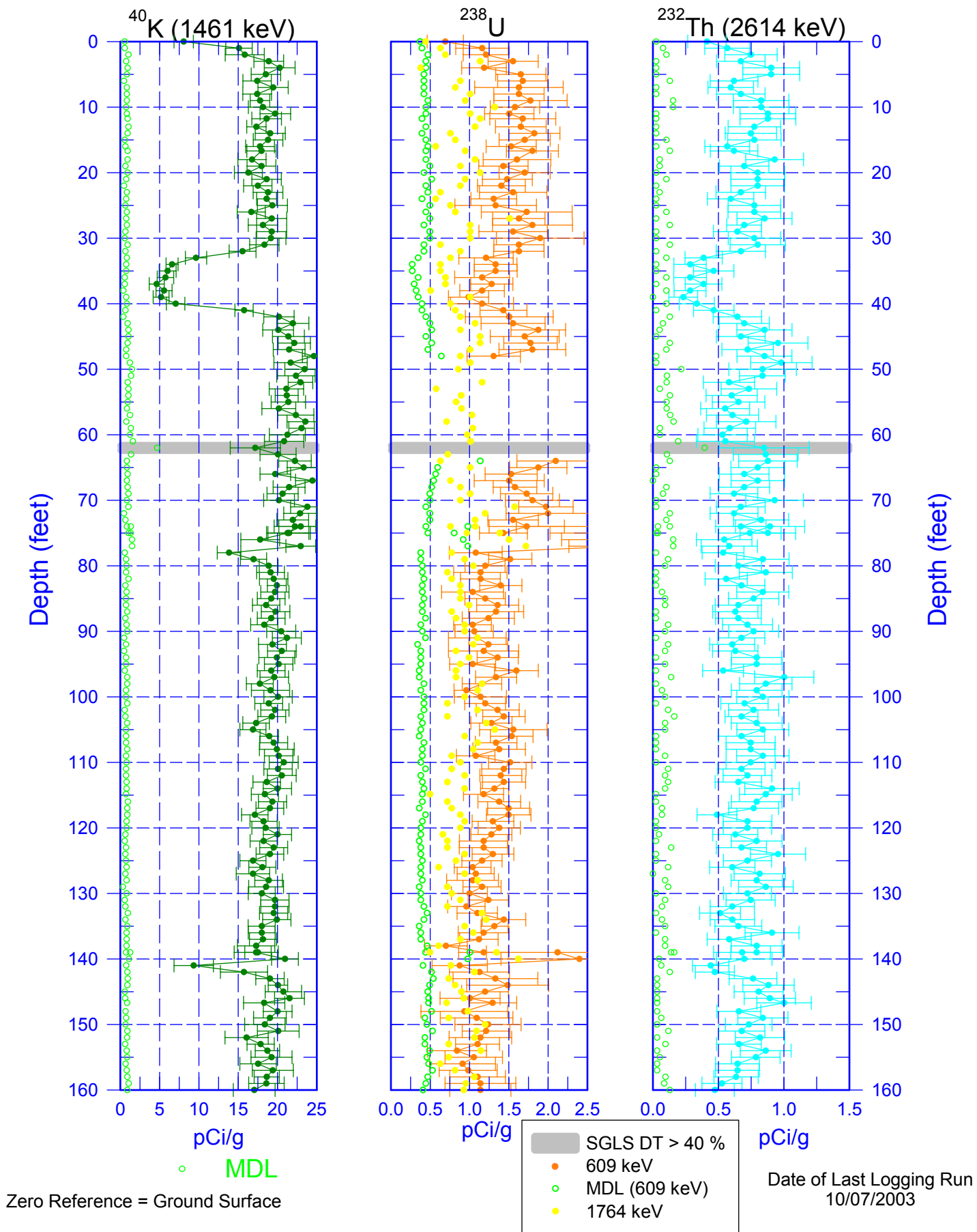


Zero Reference = Ground Surface

Date of Last Logging Run  
10/07/2003

# C3247

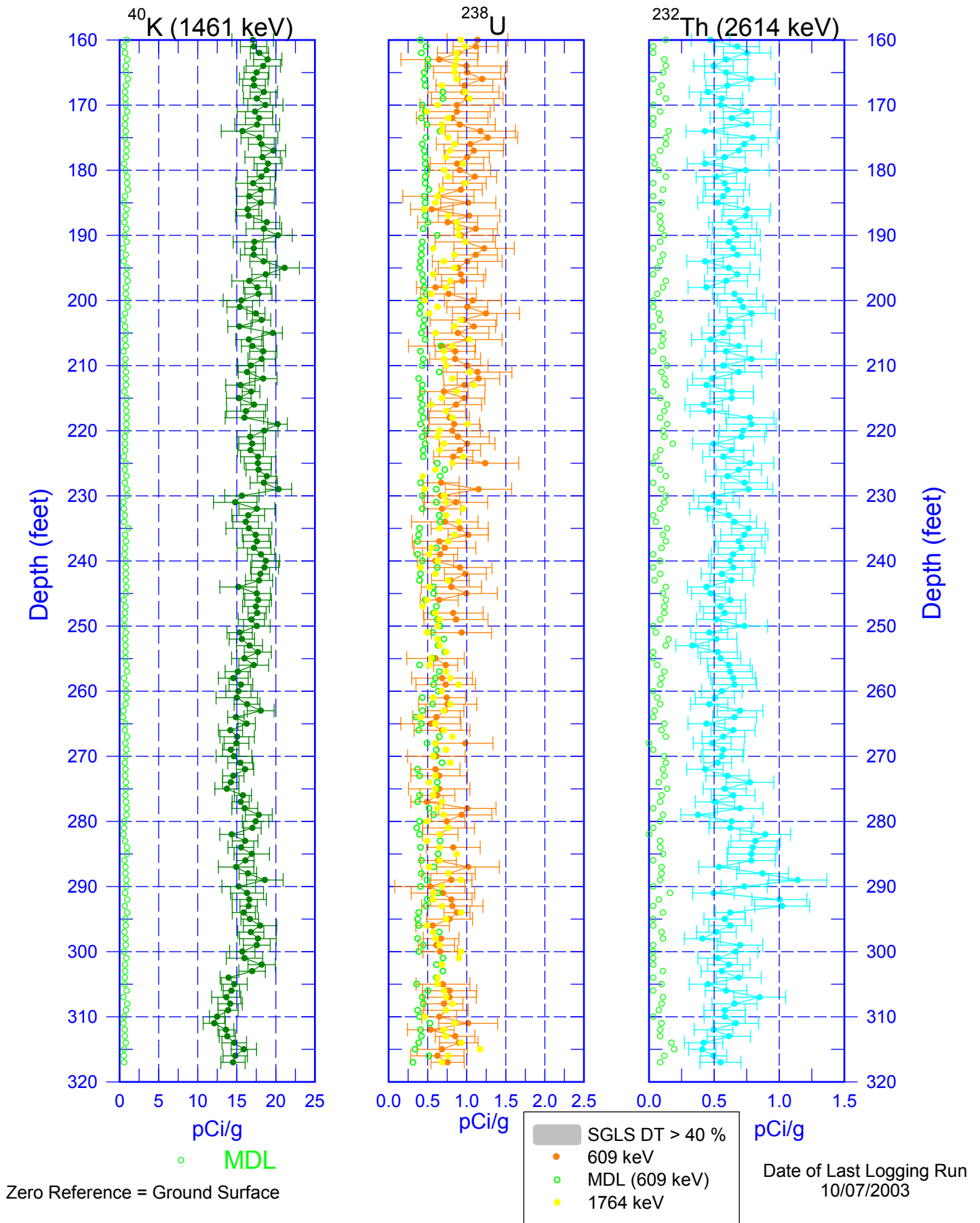
## Natural Gamma Logs



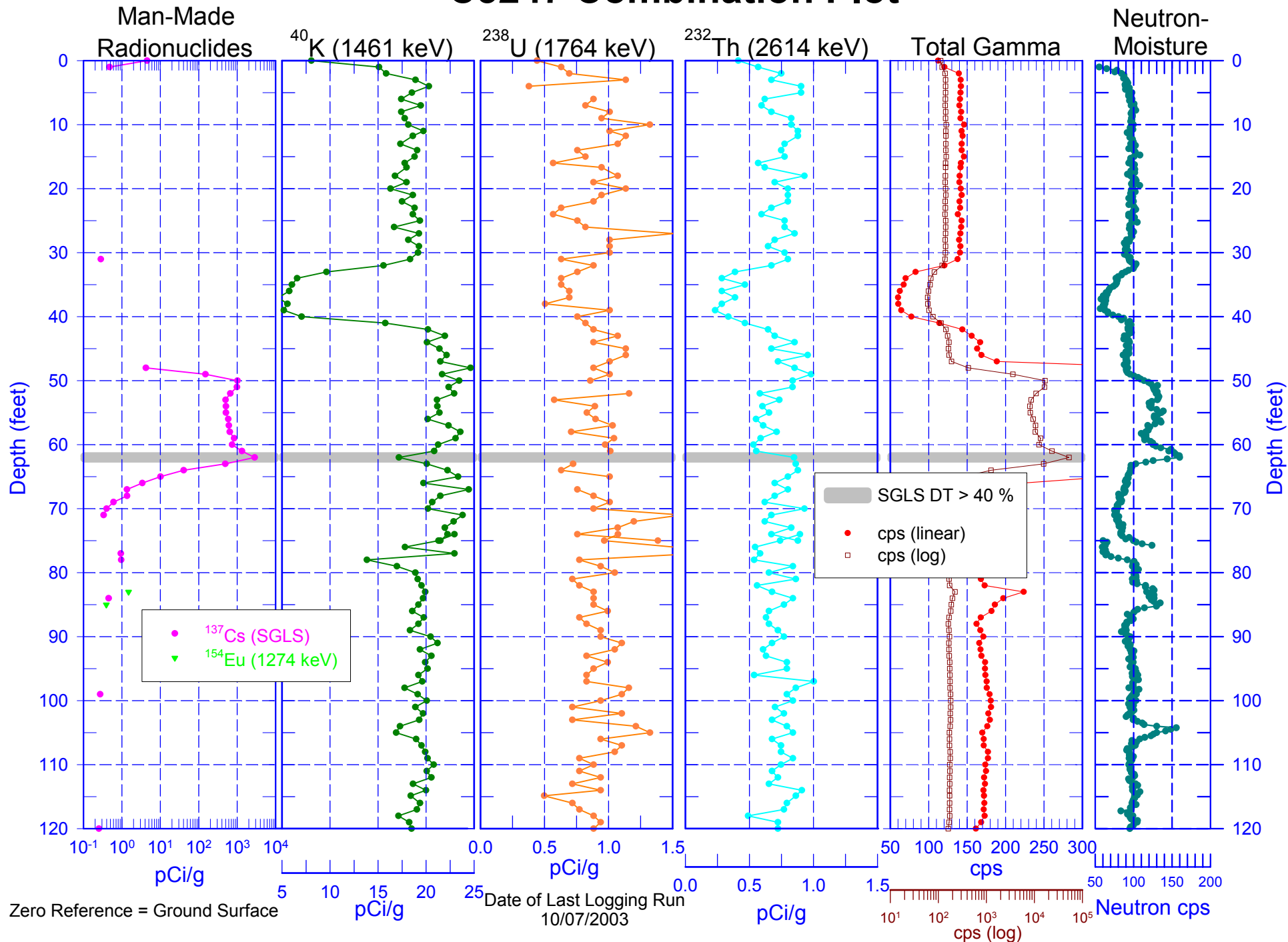


# C3247

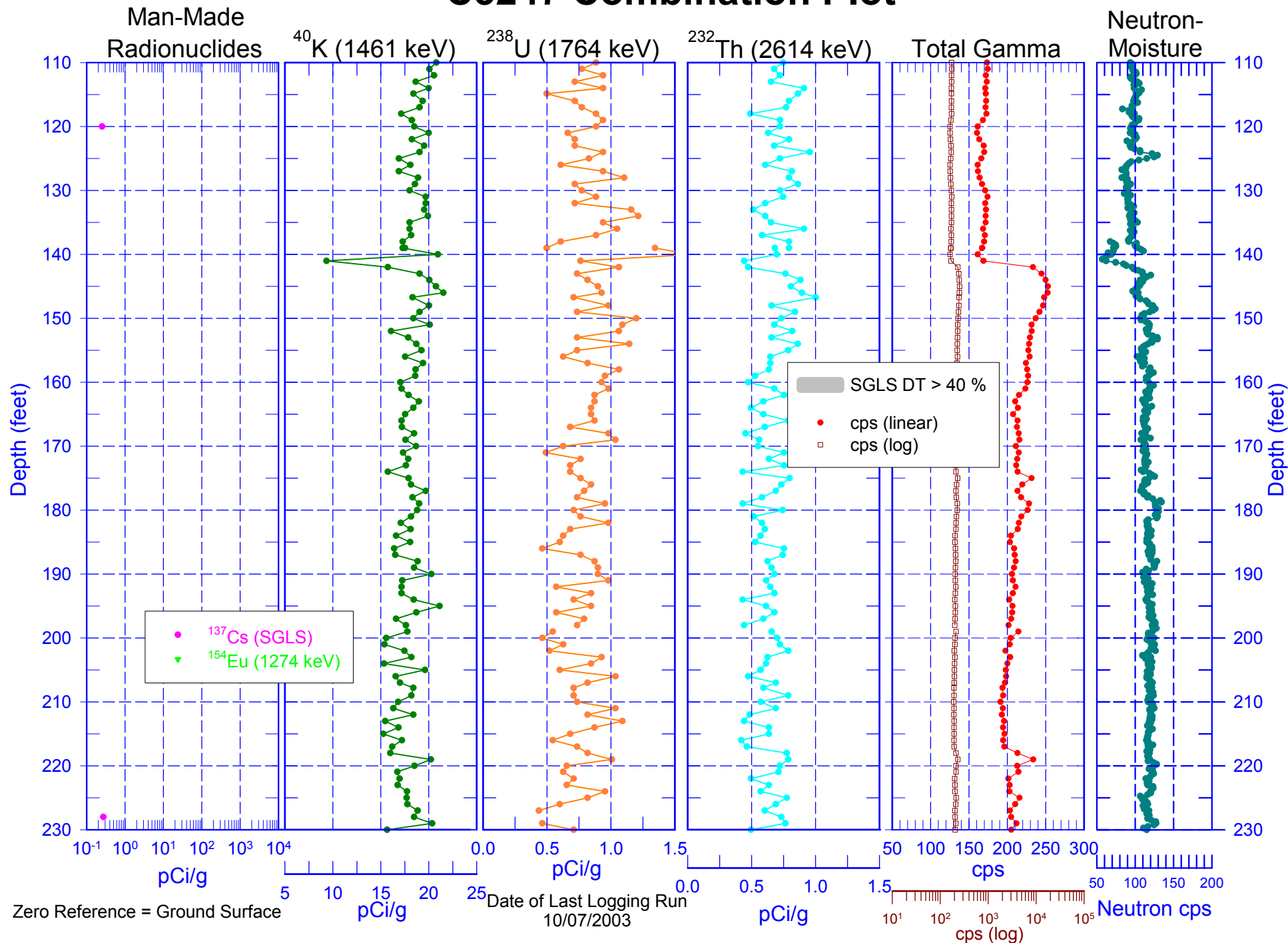
## Natural Gamma Logs



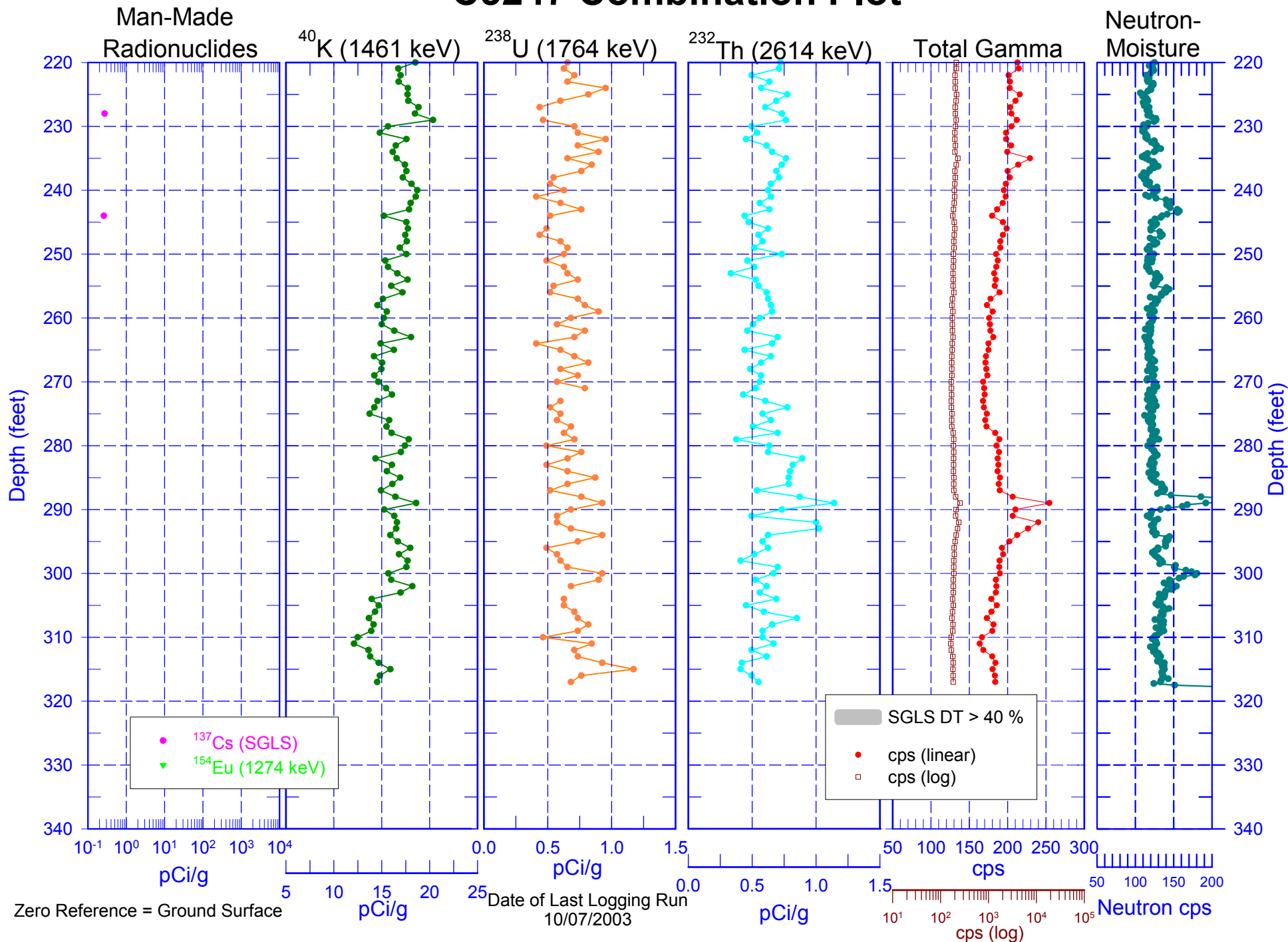
# C3247 Combination Plot



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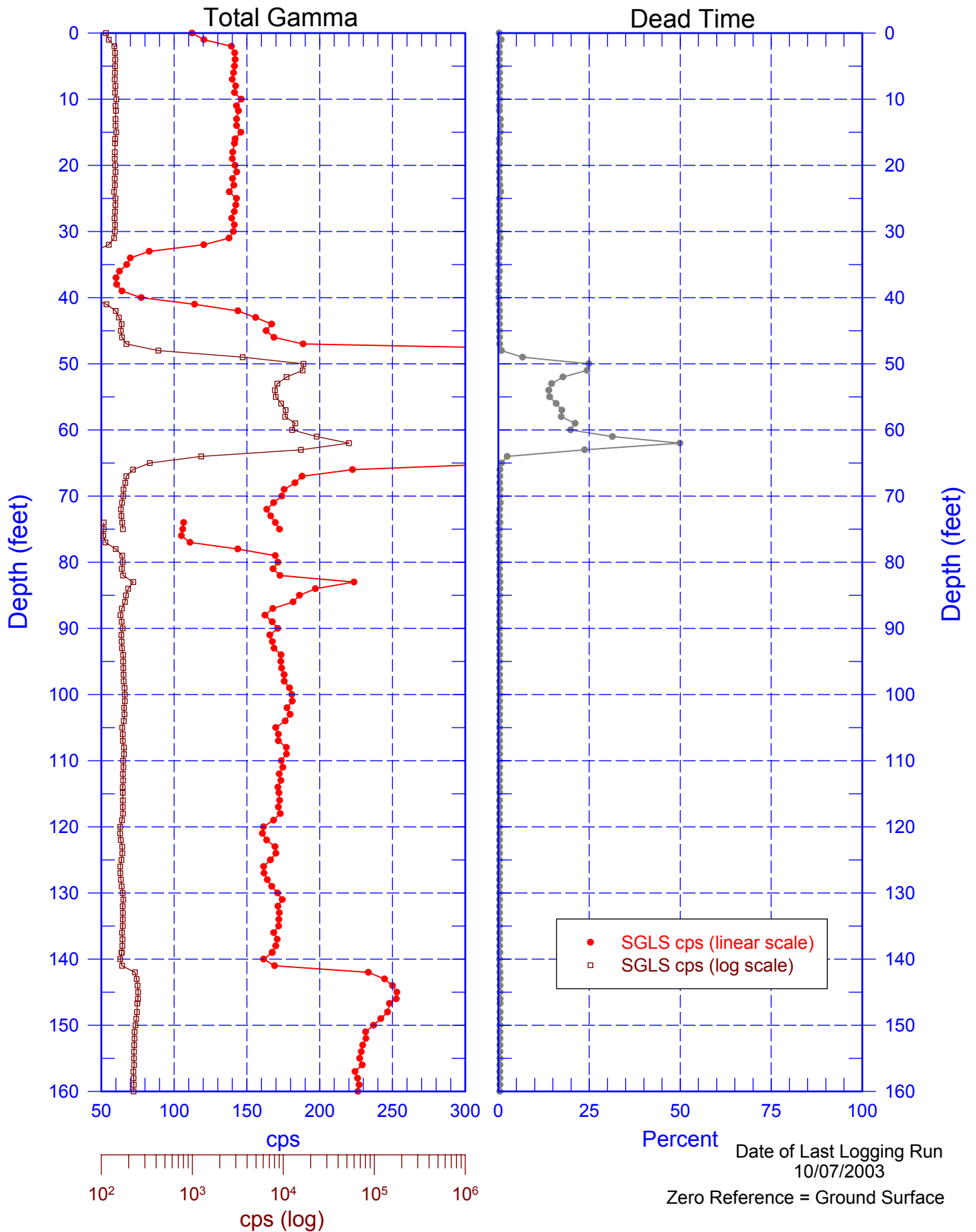


# C3247 Combination Plot



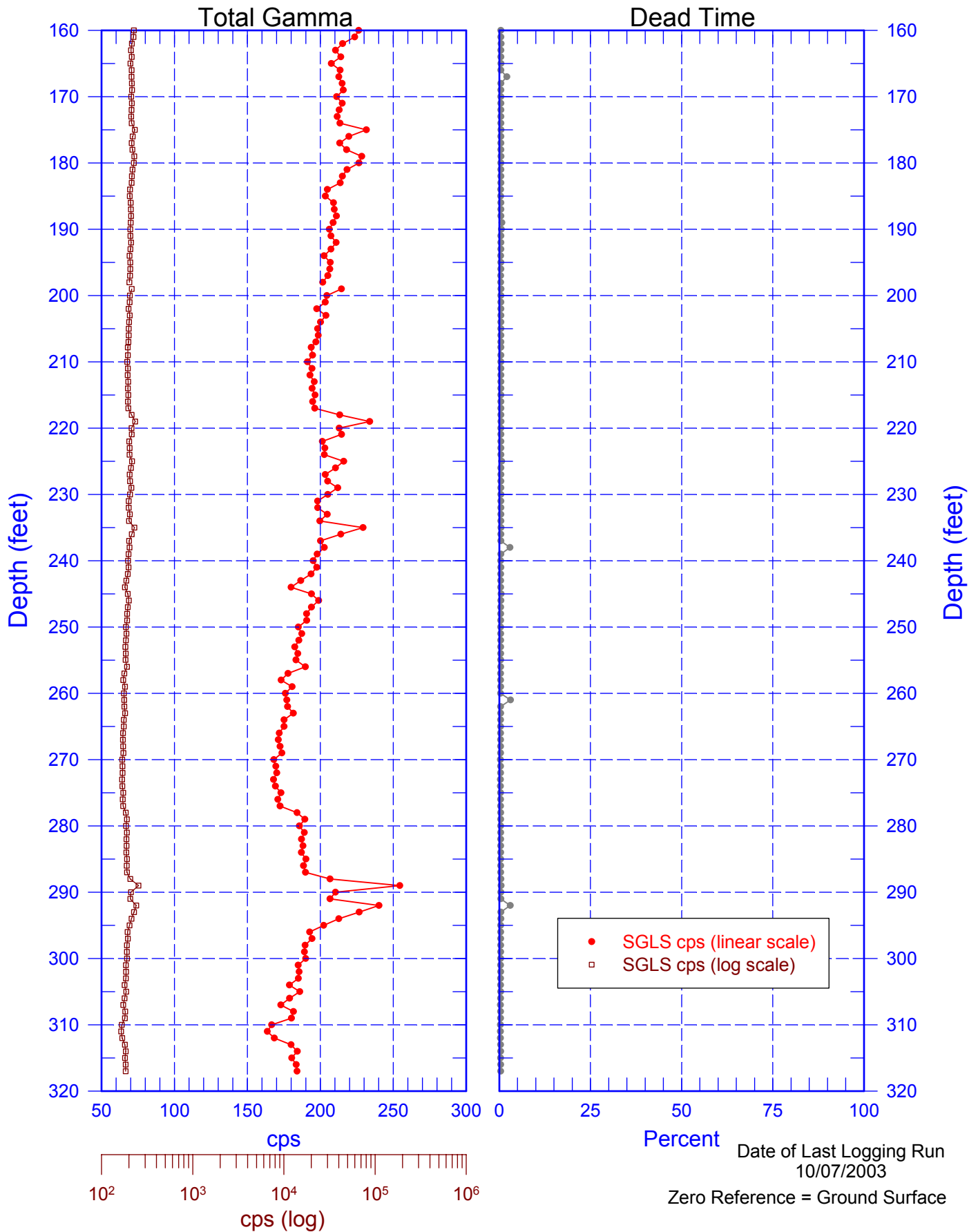
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## Total Gamma & Dead Time



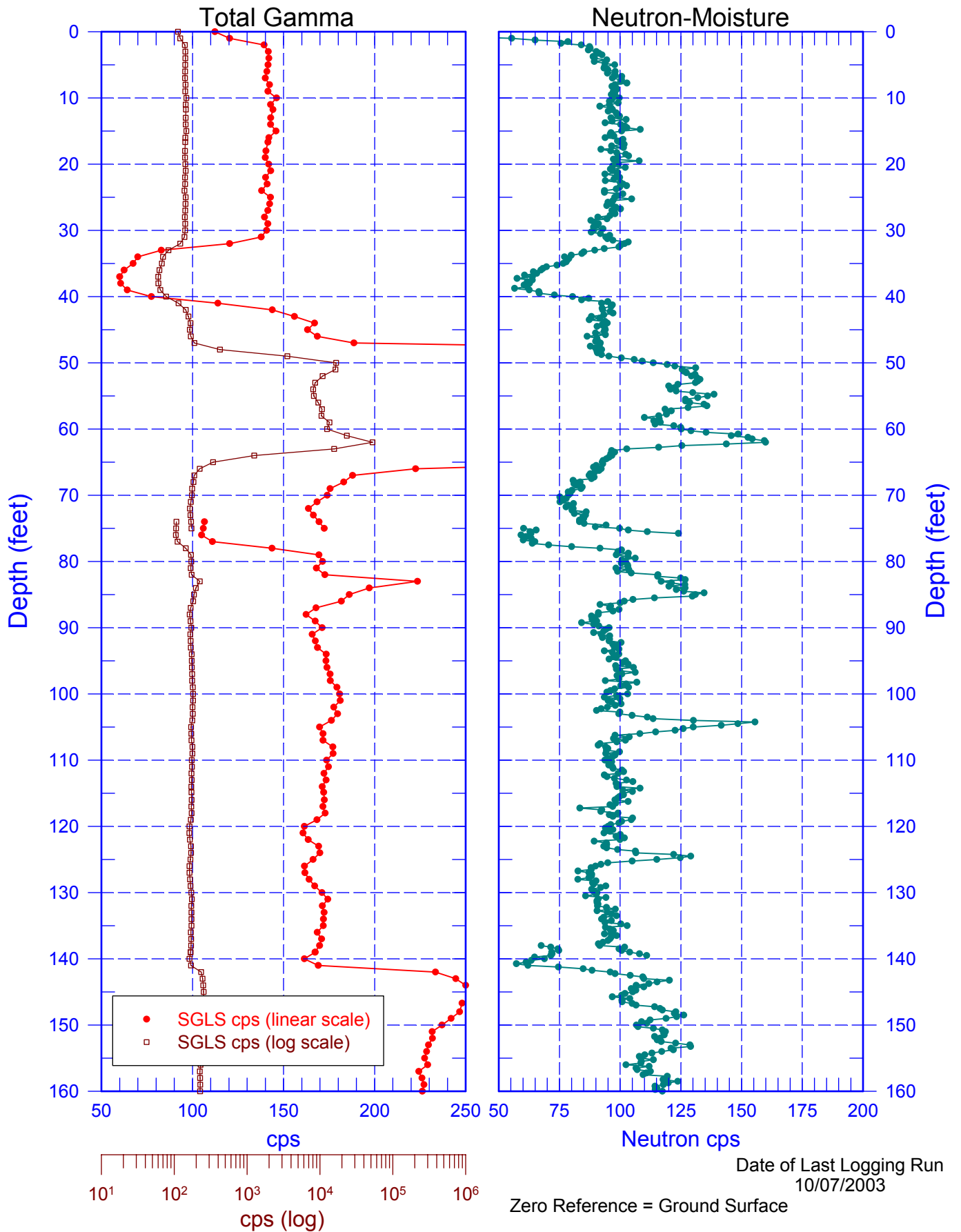
# C3247

## Total Gamma & Dead Time



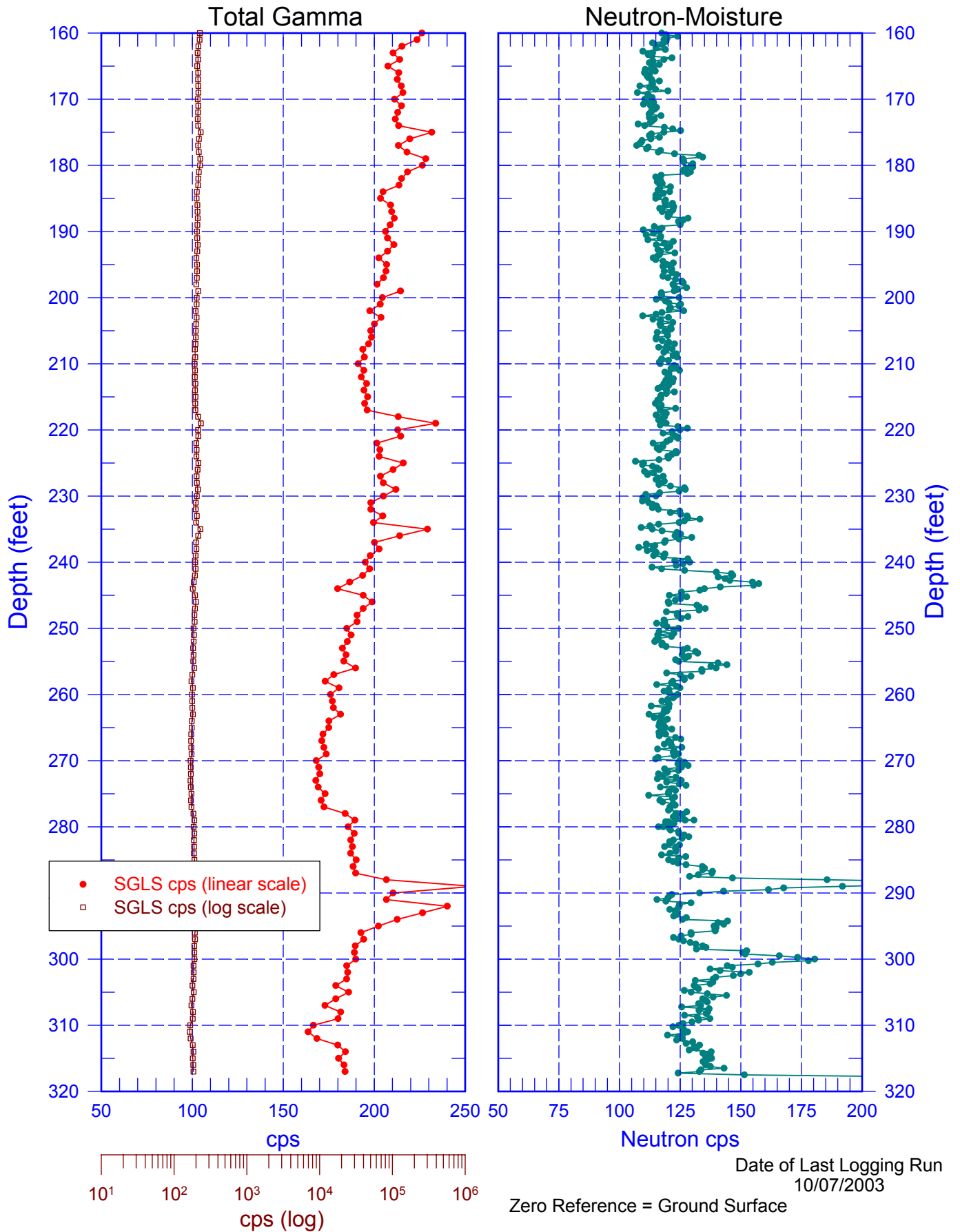
# C3247

## Total Gamma & Neutron



# C3247

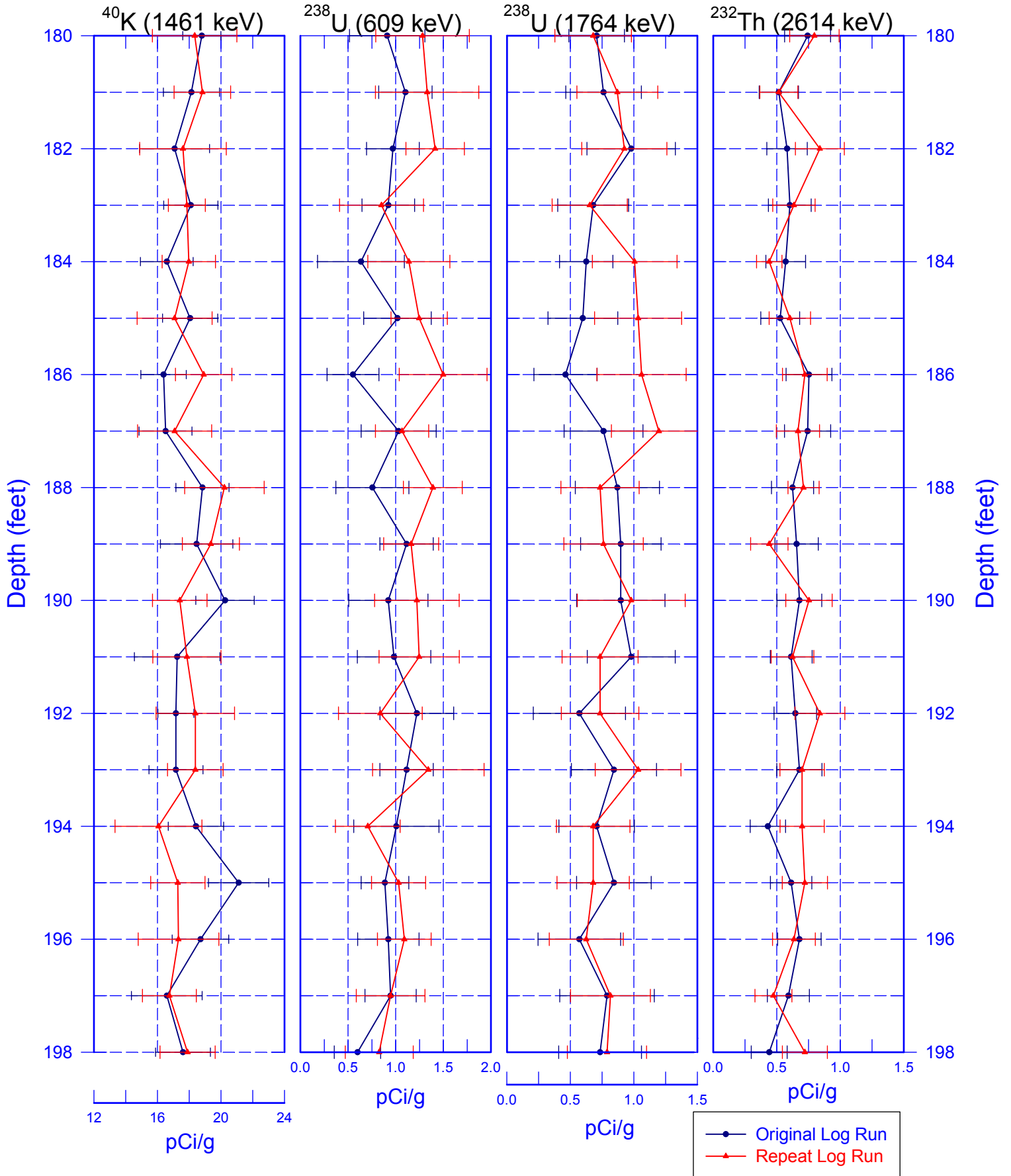
## Total Gamma & Neutron





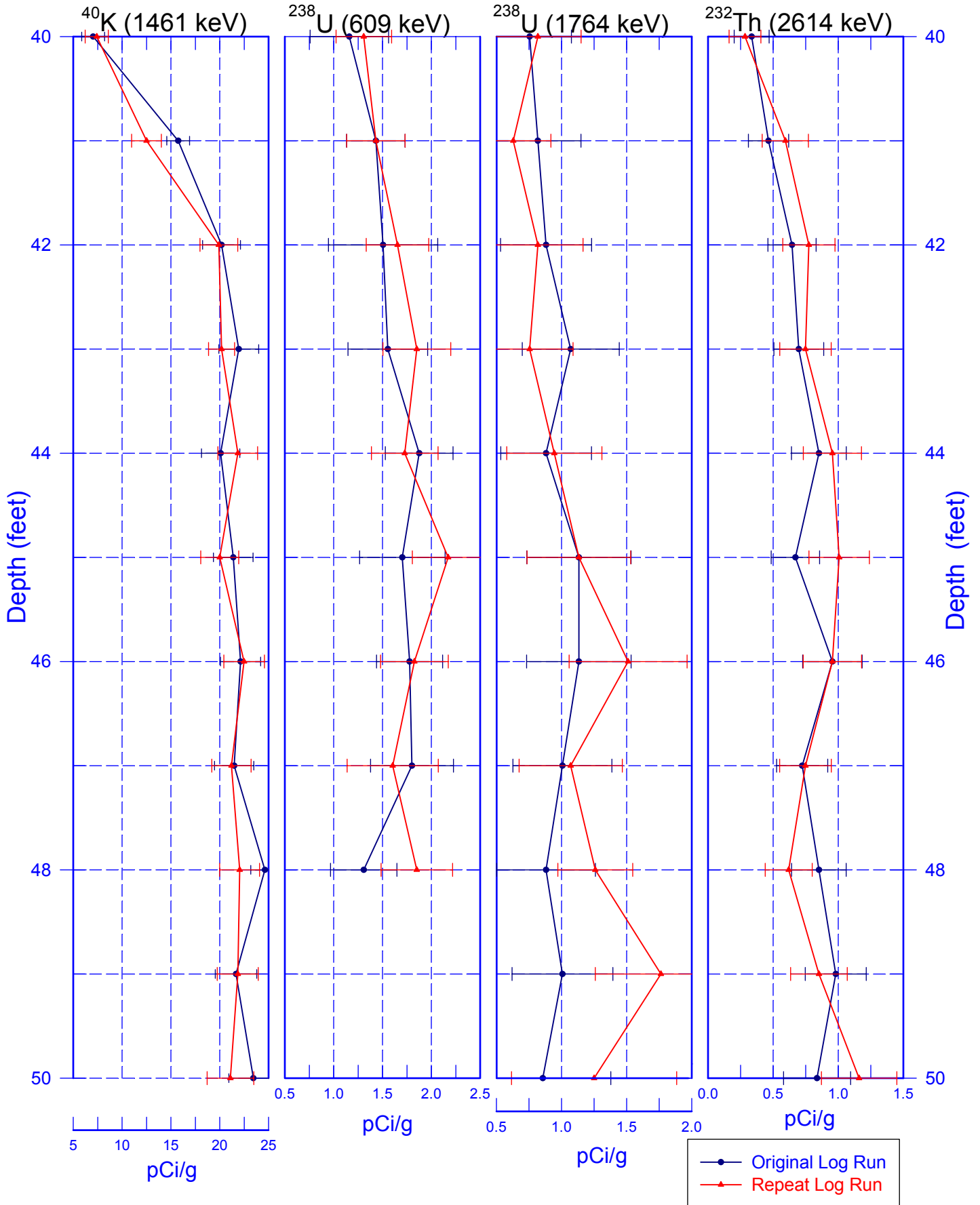
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## Rerun of Natural Gamma Logs (198.0 to 180.0 ft)



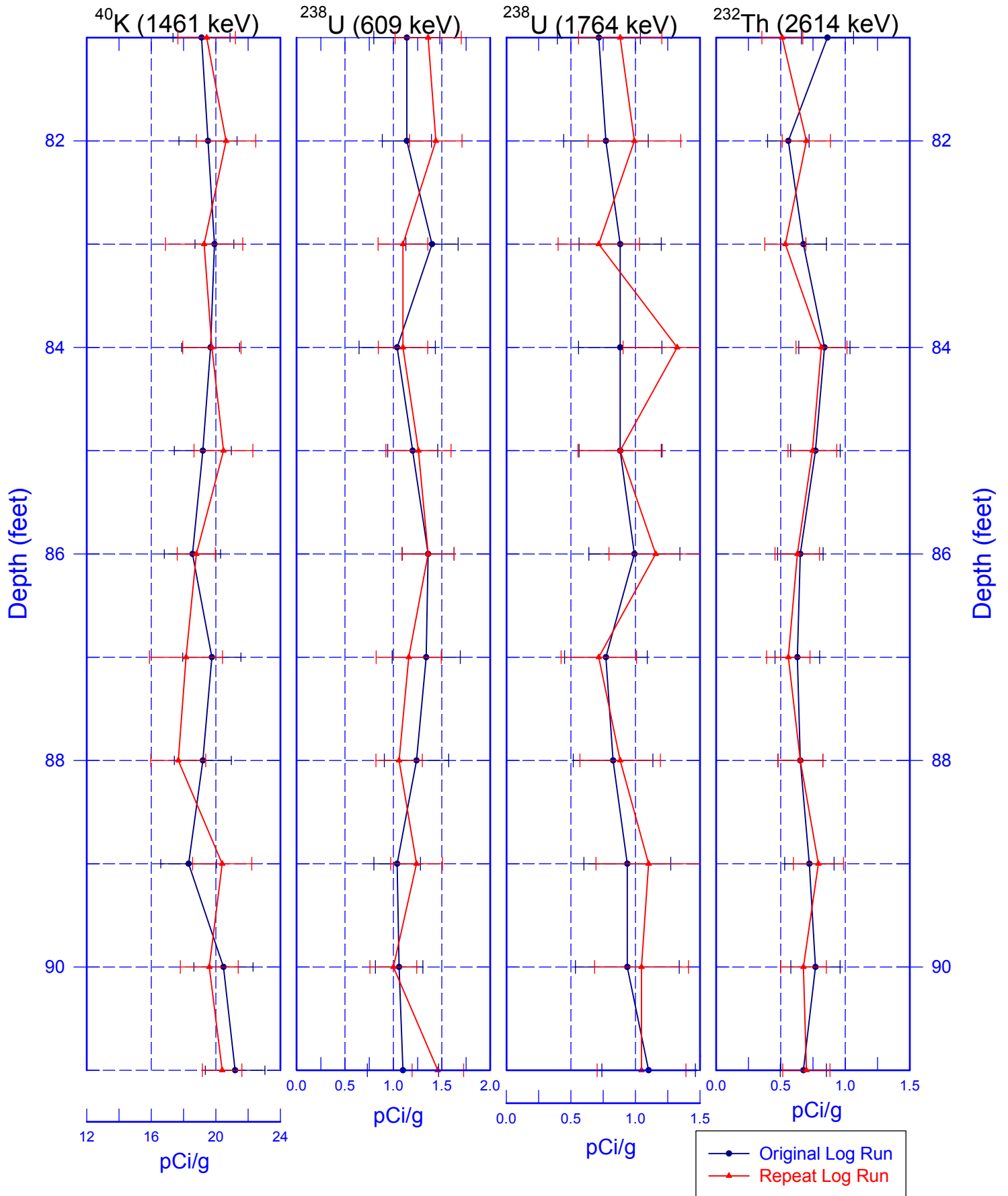
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## Rerun of Natural Gamma Logs (50.0 to 40.0 ft)



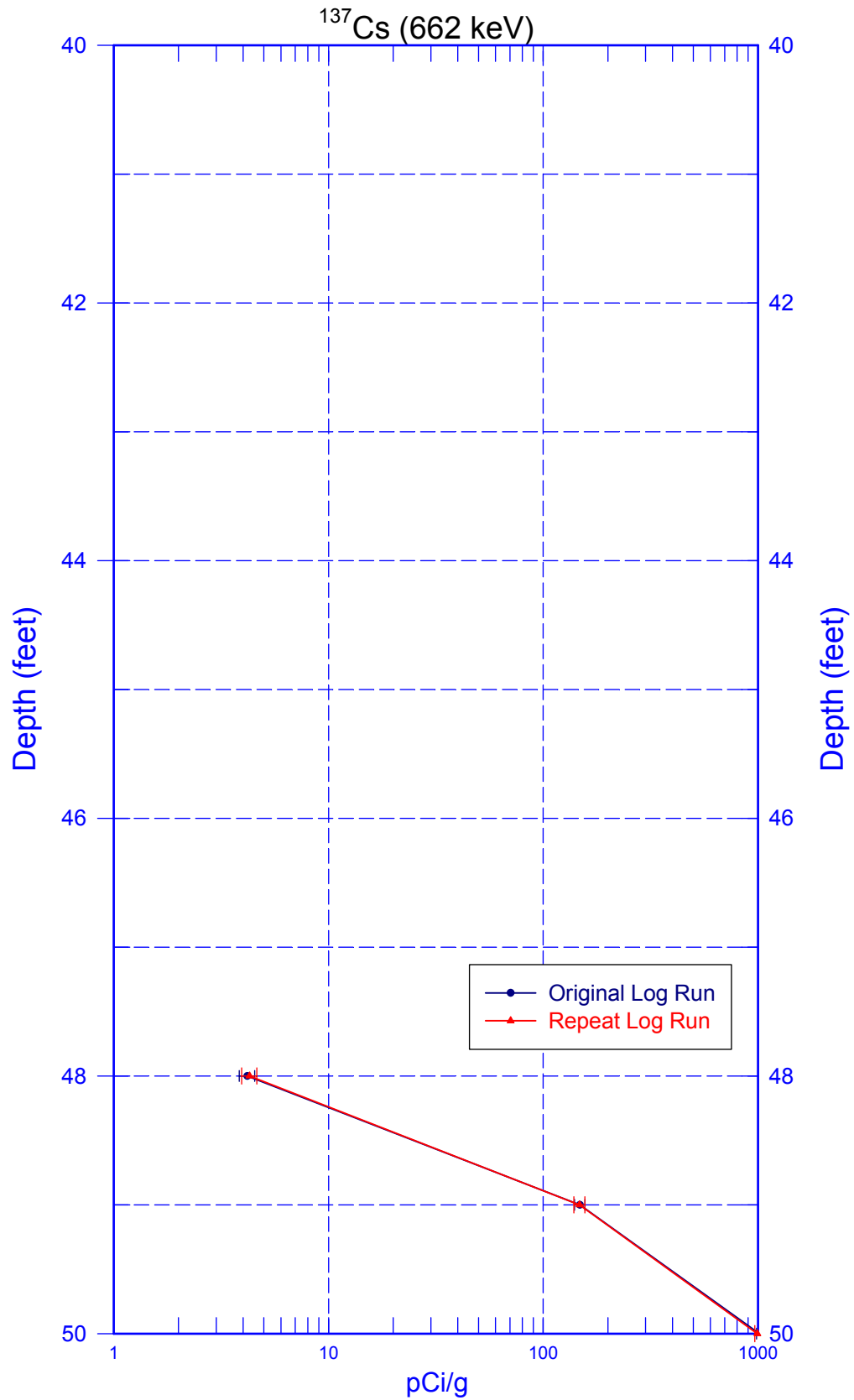
# C3247

## Rerun of Natural Gamma Logs (91.0 to 81.0 ft)



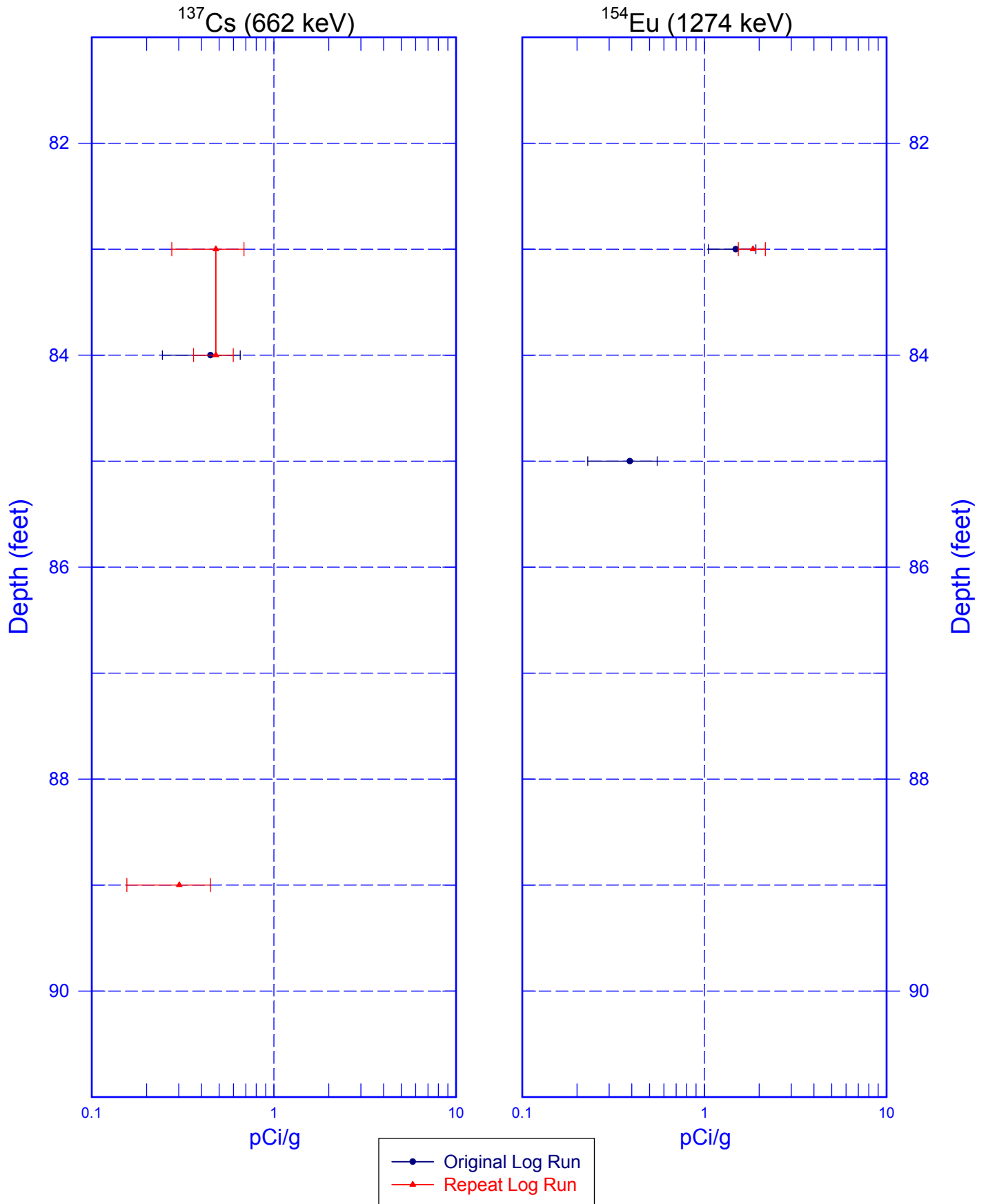
# C3247

## Rerun of Man-Made Radionuclides (50.0 to 40.0 ft)



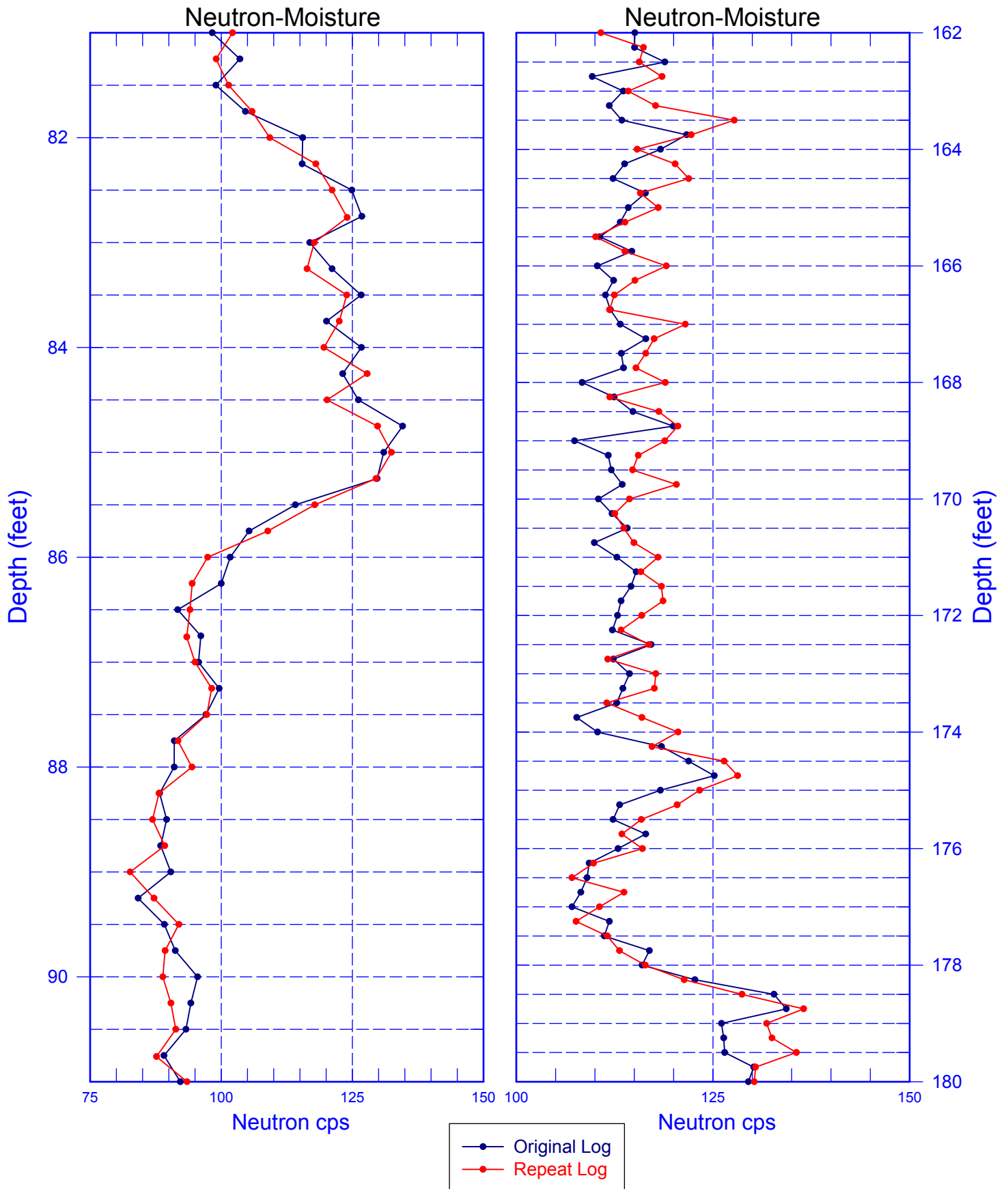
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## Rerun of Man-Made Radionuclides (81.0 to 91.0 ft)



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## Rerun of Neutron-Moisture (81.0 to 91.0 ft & 162.0 to 180.0 ft)



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## Rerun of Neutron-Moisture (59.0 to 67.0 ft)

